18 JUN 1982

1

AD A117432

AEROBIC POWER AND CORONARY RISK FACTORS IN 40 AND OVER AGED MILITARY PERSONNEL (U)

*JOHN F. PATTON, PH.D., JAMES A. VOGEL, PH.D.,
JULIUS BEDYNEK, COL, MC, DONALD ALEXANDER, MAJ, MC,
RONALD ALBRIGHT, CPT, MC

US ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE
NATICK, MA 01760
OFFICE OF THE SURGEON GENERAL, WASHINGTON, DC 20310
DWIGHT D. EISENHOWER ARMY MEDICAL CENTER, FORT GORDON, GA 30905
MARTIN ARMY COMUMUNITY HOSPITAL, FORT BENNING, GA 31905

I. INTRODUCTION

The past few years have seen considerable attention given to the assessment of aerobic fitness and the quantification of aerobic training programs in young (less than 35 years of age) Army personnel (3,15). Physical training and fitness, however, have largely been ignored for the 40 and over age group. Until recently, such personnel for the most part did not have a specific fitness program and were not required to meet any minimum fitness standard. In October 1980, the Chief of Staff, US Army, initiated a new physical training program which emphasizes the development and maintenance of cardiorespiratory fitness through aerobic training for all age groups (17-60 years) on active duty. The goal of this program is for individuals aged 40 and over to achieve sufficient aerobic fitness during a 6-month training period to meet an age-adjusted standard for the two-mile run.

Since potential health risks of both physical training and testing are greater in personnel over the age of forty, the Army physical fitness program includes a mandatory medical and cardiac screen in order to try to predict and prevent untoward cardiovascular events. The screening procedure, which the Surgeon General has proposed to take place at the time of the biannual physical exam for personnel aged 40 and over, consists of a coronary risk factor assessment as developed by the Framingham Heart Study (9).

In order to validate multiple screening procedures to identify latent coronary artery disease in asymptomatic personnel prior to conditioning training, to assess aerobic fitness following 6-months of physical training, and to make projections as to materiel and personnel costs for an Army-wide screening program, a pilot study

was conducted on 40 and over aged personnel at Ft. Benning, Georgia. This paper presents data that deals with two of the primary objectives of this study: the assessment of aerobic power and prevalence of coronary risk factors in a 40 and over aged population and, the effectiveness of the Army's new self-administered, unsupervised training program in promoting aerobic fitness.

II. METHODS

The experimental approach used in this study consisted of two testing sessions separated by a six-month training period. For the pre-training phase, 295 aged 40 and over male personnel (age range 40-53) who were available for the full six-months, volunteered to participate from approximately 600 individuals identified in this age group at Ft. Benning, GA. This sample consisted of 173 enlisted (grades E-4 to E-9) and 122 officer (grades 0-3 to 0-7) personnel who represented the typical cross-section of occupations common to any militrary installation.

During the pre-training period all subjects went through multiple, serial screening procedures to determine the prevalence of coronary risk factors and to preclude the presence of any cardiovascular disease prior to undergoing the 6-month training program. The screening included a resting 12-lead electrocardiogram (ECG), resting blood pressure, blood lipid profile to include cholesterol, triglyceride, and high density lipoprotein (HDL) determinations, fasting blood sugar, complete family medical history, smoking history ($\geq$ 10 cigarettes/day), history of medication and drug use, and a comprehensive physical examination performed by a physician to assess cardiovascular signs and symptoms. In addition, all subjects underwent a physician-supervised, multistage, symptom-limited exercise tolerance test using the US Air Force School of Aerospace Medicine (USAFSAM) treadmill protocol (23). This is a modified Balke procedure where the treadmill is set at a fixed speed of 90 m/min at 0% grade. With the speed kept constant, the grade is raised 5% every 3 min without interruption until the subject is unable to continue due to fatigue or exhaustion. To determine an individual's aerobic power, oxygen uptake was measured at each incremented stage in exercise intensity with the highest value achieved being taken as the maximal value. During the third min of each increase in intensity, the subject's expired air was collected through a mouthpiece attached to a low resistance breathing valve and into Douglas bags. An aliquot of expired air was analyzed with an Applied Electrochemistry S-3A oxygen analyzer and a Beckman LB-2 CO_2 analyzer. Expired air volumes were measured with a Collins chain-compensated gasometer. Body weight (kg) and height (cm) were determined and skinfold thickness (mm) measured at the subscapular, triceps, biceps, and suprailiac sites using Harpenden calipers. Age-adjusted regression equations were used to estimate percent body fat (5).

Individuals with abnormal treadmill results and those with normal results but who had abnormal cardiac findings or high risk factor analysis were excluded from

the training program. Of the 295 subjects initially screened, 270 were cleared to take part in the Army's new self-administered, individualized physical training program (Army FM 21-20 Physical Readiness Training. Final Draft. Sect. IV page 3-1 thru 3-10, 1980). This program consists of a progressive walk/run mode of exercise where subjects enter the program, depending upon their initial level of physical activity, at one of three phases: preparatory, conditioning, or maintenance. Each of these phases consists of a progressive scale as to duration and frequency of exercise. Sedentary individuals enter the program in the preparatory phase while those who have been exercising enter either the conditioning or maintenance phase at an appropriate level.

Each subject was given a written description of the training program and provided guidance in choosing and implementing a regimen to fit his particular needs. A personal physical activity history was taken on each individual before and after the 6-months of training. For the purpose of data analysis, subjects in the pre-training phase were classified into one of the three following groups according to their level of physical activity: inactive, runs zero to 3 mi/wk; moderately active, runs greater than 3 but less than 10 mi/wk; and active, runs more than 10 mi/wk.

For a variety of reasons, e.g. retirements, medical profiles, temporary duty assignments, only 165 of the 270 subjects originally cleared were available for re-testing at the completion of the 6-months training. The efficacy of the training program was determined by repeating the measurement of maximal oxygen uptake using the same procedure as that used during the pre-training phase.

III. RESULTS

The results of this study are presented in two parts: first, a cross-sectional description of aerobic fitness, the prevalence of coronary risk factors and the relationship between fitness and risk factors in the 40 and over sample studied is presented, and secondly, a longitudinal evaluation is made of the effects of the six-month training program in enhancing aerobic fitness.

The mean data for age, anthropometric measures and the physiological responses to exercise for the enlisted and officer personnel and for the total sample studied during the pretraining period are presented in Table 1. No differences were seen in age or any of the anthropometric measures between the enlisted and officer groups. However, the enlisted group had a 9% lower $\dot{V}O_2$ max ($p < .05$) compared to the officers on both an absolute (l/min), and relative basis (ml/kg • min). The mean $\dot{V}O_2$ max of 38.1 ± 6.2 ml/kg • min represents a fairly typical aerobic fitness level for this age group. The range in $\dot{V}O_2$ max from 25.3 to 61.1 ml/kg • min suggests a large variation in fitness for this group. It is felt, therefore, that due to this range and the nature of the subject selection the sample is representative of 40 and over aged personnel throughout the Army.

TABLE 1. Age, anthropometric measures and maximal physiological responses to exercise prior to training (mean $\pm$ SD)

	Enlisted (n=168)	Officers (n=102)	Total (n=270)	Range
Age (yrs)	43.4 $\pm$ 2.7	44.5 $\pm$ 3.3	43.8 $\pm$ 3.0	40-53
Height (cm)	83.7 $\pm$ 12.7	83.9 $\pm$ 10.5	83.7 $\pm$ 11.4	56.6-115.7
Weight (kg)	177.7 $\pm$ 6.6	180.5 $\pm$ 6.7	178.9 $\pm$ 6.7	155-196
Body Fat (%)	26.2 $\pm$ 4.8	25.9 $\pm$ 4.4	26.0 $\pm$ 4.6	11.6-36.5
$\dot{V}O_2$ max (l/min)	3.04 $\pm$ 0.51	3.35 $\pm$ 0.48*	3.16 $\pm$ 0.52	1.71-4.58
$\dot{V}O_2$ max (ml/kg • min)	36.7 $\pm$ 5.5	40.3 $\pm$ 6.5*	38.1 $\pm$ 6.2	25.3-61.1
HRmax (BPM)	182 $\pm$ 9	181 $\pm$ 9	181.6 $\pm$ 9.2	157-203
$\dot{V}_E$ max (l/min BTPS)	119 $\pm$ 23	130 $\pm$ 23	123 $\pm$ 24	61-219

*p < .05 compared to enlisted

STAMP Security Classification

In Table 2 values of $\dot{V}O_2$ max are presented from various studies on healthy males between 40 and 55 years of age. Because of differences in physical activity history among the samples and in the techniques used to elicit $\dot{V}O_2$ max (treadmill vs. cycle ergometer), the results are not directly comparable. However, if one takes into account the lower values obtained using the cycle ergometer, it can be generally stated that a mean $\dot{V}O_2$ max is in the mid to upper 30's in ml/kg • min for this age group.

In Table 3 are presented the mean data and ranges for selected risk factors and the risk factor index calculated using the Framingham equations (9).

The prevalence of coronary risk factors for subjects divided into the two age groups 40-44 (n=196) and 45-53 (n=98) is presented in Table 4. Obesity (> 25% body fat), elevated serum cholesterol (> 200 mg/dl) and cigarette smoking (50% of subjects) appear to be the most predominant risk factors in both age groups. There was no difference between the two groups in the prevalence of obesity as nearly 64% of the individuals in both had body fat contents greater than 25%. Also, the percentage of low aerobically fit subjects ($\dot{V}O_2$ max < 35 ml/kg • min) was not different between the age groups and was 32.7% overall. Significant differences between the two groups were only seen in ECG abnormalities both at rest and after exercise and in the number of subjects with a risk factor index $\geq$ 5%. This latter difference is attributable almost entirely to the age difference of the groups and to the greater number of abnormal resting ECG in the older group since the other variables used to calculate the risk factor index (systolic blood pressure, fasting blood sugar, serum cholesterol, smoking history) were not different between groups.

Data comparing levels of cardiorespiratory fitness with coronary risk factor variables are shown in Table 5. The fitness levels correspond to the following ranges of $\dot{V}O_2$ max in ml/kg • min: very poor, < 30; poor, $\geq$ 30 < 35; fair, $\geq$ 35 < 40; good $\geq$ 40 > 45; excellent, > 45. Only statistically significant values related to the excellent level of fitness are included. Intergroup comparisons showed no significant differences between the good and excellent levels of fitness except for body weight, % body fat, and serum HDL levels. Further analyses demonstrated a significant difference between the very poor and poor categories for fasting blood sugar, body weight and % body fat. The good and fair levels of fitness differed significantly only with respect to the risk factor index and percent smokers. Differences between the poor and fair groups were shown in HDL levels, the cholesterol/HDL ratio and percent smokers. The fair to very poor groups differed significantly in body weight, % body fat, diastolic blood pressure, cholesterol/HDL ratio, fasting blood sugar, percent smokers and risk factor index.

TABLE 2. Comparison of $\dot{V}O_2$ max data from present study with other studies of 40-55 year-old males.

Investigator	Age (yr)	n	Testing Mode*	$\dot{V}O_2$ max (ml/kg • min)
Ribisl (18)	40.2	15	CE	40.1
Saltin et al. (19)	40.5	42	CE	37.5
Wilmore et al. (22)	40.5	16	CE	40.1
Naughton & Nagle (12)	41.0	18	CE	31.3
Hanson et al. (7)	48.9	7	CE	35.8
Pollock et al. (17)	48.9	15	TM	29.9
Froelicher et al. (6)	40 - 44	59	TM	34.0
	45 - 49	68	TM	33.5
	50 - 53	19	TM	34.0
Cumming et al. (2)	40 - 45	22	CE	31.9
	46 - 49	14	CE	30.4
	50 - 55	22	CE	30.0
Present Study	40 - 53	260	TM	38.1

*CE = Cycle Ergometer; TM = Treadmill

TABLE 3. Selected risk factors of subjects during the pretraining period (n=295)

Variable	Mean + SD	Range
Blood Pressure		
Systolic	124 ± 14	100-194
Diastolic	81 ± 9	55-120
Cholesterol (mg/dl)	215 + 38	95-354
HDL (mg/dl)	41.2 + 11.5	13.6-99.2
Chol/HDL	5.5 ± 1.6	1.0-9.9
Triglycerides (mg/dl)	159 ± 112	11-599
Fasting Blood Sugar (mg/dl)	98 ± 20	75-334
Risk Index (%)	3.4 ± 0.2	0.7-16.9

STAMP Security Classification here

TABLE 4. Prevalence of coronary risk factors by age groups.

Risk Factors	Prevalence (Percent)		
	40-44	45-53	Total
% Body Fat			
$> 25 \leq 30$	46.5	46.2	46.4
> 30	17.5	17.2	17.4
$\dot{V}O_2$ max (ml/kg • min)			
$\leq 30 \leq 35$	23.5	25.6	24.2
< 30	7.1	11.1	8.5
Blood Pressure			
$\geq 140/90 \leq 160/95$	18.0	17.4	17.8
$> 160/95$	7.2	4.1	6.1
Cholesterol (mg/dl)			
$\geq 200 \leq 250$	46.7	37.8	44.0
> 250	14.9	23.5	17.8
Cholesterol/HDL			
≥ 6.0	33.3	32.7	33.1
Fasting Blood Sugar			
≥ 115 mg/dl	7.2	7.1	7.2
Triglycerides			
≥ 150 mg/dl	38.5	46.9	41.3
ECG Abnormalities			
At Rest	13.4	23.5+	16.8
At Exercise	6.6	17.0*	10.1
Cigarette Smoking	51.0	49.0	50.3
Positive Family History	27.6	23.5	26.2
Abnormal Cardiac Exam	38.6	50.5	42.8
Risk Factor Index			
$\geq 5\%$	10.3	32.0**	26.7

+ $p < .05$; * $p < .01$; ** $p < .001$

TABLE 5. Physical fitness levels vs. anthropometric measures and coronary risk factors (Mean ± SD).

	Very Poor (n=22)	Poor (n=59)	Fair (n=84)	Good (n=58)	Excellent (n=32)
Age (yr)	44.5 ± 3.6	43.9 ± 2.7	44.1 ± 2.9	43.8 ± 3.4	42.8 ± 2.1
Hgt (cm)	180.6 ± 5.8	179.5 ± 6.3	178.0 ± 6.5	179.2 ± 7.5	178.4 ± 7.4
Wgt (kg)	95.5 ± 13.7**	85.6 ± 11.3**	83.4 ± 10.5**	82.0 ± 9.2*	76.0 ± 8.2
%BF	31.0 ± 4.4**	26.8 ± 4.2**	26.1 ± 4.2**	24.8 ± 4.4*	22.9 ± 3.9
SBP	129 ± 21*	124 ± 15	125 ± 13*	122 ± 12	119 ± 11
DBP	86 ± 12**	82 ± 8*	81 ± 8*	80 ± 9	77 ± 7
Chol (mg/dl)	222 ± 41*	224 ± 39*	217 ± 35*	205 ± 38	203 ± 37
HDL (mg/dl)	38.1 ± 10.9**	37.7 ± 7.6**	41.8 ± 10.4**	42.6 ± 13.4*	48.1 ± 16.3
CHOL/HDL	6.1 ± 1.8**	6.1 ± 1.5**	5.4 ± 1.5*	5.1 ± 1.6	4.6 ± 1.6
TRIG (mg/dl)	189 ± 109*	172 ± 115*	171 ± 138*	137 ± 76	122 ± 66
FBS (mg/dl)	110 ± 34**	98 ± 10	96 ± 11	94 ± 10	93 ± 8
Smokers (%)	77**	72**	48*	29	22
RF Index (%)	4.7 ± 3.5**	4.0 ± 2.5*	3.4 ± 2.1*	2.6 ± 1.8	2.5 ± 1.6

*p<.05; ** p<.01 when compared to excellent level of physical fitness. SBP - systolic blood pressure; DBP - diastolic blood pressure; CHOL - Cholesterol; TRIG - triglycerides; FBS - fasting blood sugar; RF - risk factor.

In order to quantify any change in aerobic power as a result of participating in the new self-administered, unsupervised training program, subjects were divided into three groups based on their initial level of physical activity as assessed by interview during the pre-training period. These three groups, with the number of subjects shown in parentheses, were as follows: inactive (140), runs zero to 3 mi/wk; moderately active (53), runs more than 3 but less than 10 mi/wk; and active (55), runs 10 or more mi/wk. Twelve individuals indicated that they participated in other activities, i.e., swimming, racquetball, tennis, etc., but they were not included in the activity estimation.

Table 6 presents the mean anthropometric and maximal physiologic data for subjects comprising the three activity groups prior to physical training. No differences were seen in body weight or % body fat among the three groups. $\dot{V}O_2$ max of the active group was 17% and 16% higher ($p < .01$) compared to the inactive group on an absolute (l/min) and relative (ml/kg • min) basis, respectively. The moderately active group also showed a significantly higher $\dot{V}O_2$ max ($p < .01$) compared to the inactive group. The interview procedure used to establish physical activity habits was effective, therefore, in separating individuals into three levels of aerobic fitness.

TABLE 6. Anthropometric and maximal physiological data for subjects grouped by physical activity history prior to training (Mean ± SD).

	Activity Group: Inactive n = 140	Moderately Active n = 53	Active n = 55
Age (yrs)	43.9 ± 3.1	43.5 ± 2.6	43.6 ± 3.1
Ht (cm)	178.0 ± 6.6	179.7 ± 6.9	179.6 ± 6.9
Wt (kg)	83.9 ± 12.8	83.2 ± 10.0	84.4 ± 11.0
% Body Fat	26.1 ± 4.7	25.9 ± 4.9	26.1 ± 4.1
$\dot{V}O_2$ max (l/min)	2.99 ± 0.46[a,b]	3.31 ± 0.52	3.49 ± 0.49
$\dot{V}O_2$ max (ml/kg • min)	36.1 ± 5.3[a,b]	39.8 ± 5.4	41.9 ± 6.7
HR max	182 ± 10[b]	183 ± 9	178 ± 7
$\dot{V}_E$ max (l/min BTPS)	120 ± 23[b]	125 ± 24	131 ± 24
Max TM Time (min)	14.6 ± 2.7[a,b]	16.0 ± 2.7	16.8 ± 2.7

a = significantly different from moderately active group;
b = significantly different from active group. $p < .01$ ANOVA

Data on body composition and maximal responses to exercise determined before and after the 6-months prescribed training program are depicted for the three groups in Table 7. Of the 140 individuals who were initially classified as being inactive, only 78 (56%) were available for retesting. Thirty-four of these subjects indicated during a post-training interview that they had not participated to any significant degree in the program; forty-four subjects indicated that they participated to an extent that would be expected to produce a significant increase in $\dot{V}O_2$ max. There were no changes in body weight or % body fat in either of these subgroups upon retesting after 6 months. With respect to $\dot{V}O_2$ max, only a slight and insignificant increase (4.4%) was seen in those subjects who indicated they had participated in the program. For the moderately active and active groups, 76% (39 of 53) and 80% (44 of 55) of the subjects were retested, respectively. Neither of these groups showed any changes in aerobic power or body composition during the training period.

IV. DISCUSSION

This study represents perhaps the largest assessment of aerobic power using a direct measurement of $\dot{V}O_2$ max that has been performed in a 40 and over aged population. The results suggest that aerobic fitness of US Army personnel in this age group does not differ significantly from civilians of comparable age. This may not be surprising since members of the Army work in occupations similar to those found in the civilian sector of our society.

There have been few studies on other military populations to which the present results can be compared. In a select group of US Military Academy faculty and staff over 35 years of age, Kowal et al. (10) reported a $\dot{V}O_2$ max, using a treadmill protocol, of 41.4 and 50.6 ml/kg • min for low and high activity groups respectively. In USAF aircrewmen of similar age to those of the present study, Froelicher et al. (6) found an average $\dot{V}O_2$ max of 34.0 ml/kg • min using a treadmill protocol. Myles and Allen (11) in a survey of Canadian forces personnel aged 40-55 reported a mean value of 32.4 ml/kg • min using a submaximal predictive cycle ergometer test. If these data are corrected upward, however, by 15% for differences between cycle ergometer and treadmill as suggested by Shepard (20), then the results compare quite closely to the present data. While valid comparisons among studies are difficult due to differences in testing methods used to elicit $\dot{V}O_2$ max and in the physical activity history of the subjects it can generally be stated that a typical $\dot{V}O_2$ max for the 40 and over age group ranges from 35 to 40 ml/kg • min.

The data presented on the prevalence of coronary risk factors in 40 and over aged military personnel showed obesity, elevated blood cholesterol and cigarette smoking to be the most predominant factors. Obesity has been identified as one of the most prevalent health problems at all ages in the United States and has been shown to be a definite risk factor for development of coronary artery disease (8). The 63.8% prevalence of body fat content in excess of 25% (17.4% in excess of

TABLE 7. Anthropometric and maximal physiological data by activity group before and after 6-months training (mean ± SD).

		Activity Group			
		Inactive		Moderately Active	Active
		Nonparticipants	Participants		
		(N = 34)	(N = 44)	(N = 39)	(N = 44)
Weight (kg)	Pre-T*	84.0 ± 11.5	83.8 ± 11.8	84.6 ± 10.6	82.8 ± 11.1
	Post-T	83.4 ± 10.3	83.1 ± 10.9	84.5 ± 9.5	82.5 ± 10.2
% Body Fat	Pre-T	24.9 ± 5.6	26.2 ± 4.4	25.8 ± 4.9	25.7 ± 4.4
	Post-T	25.2 ± 5.0	26.7 ± 4.1	26.0 ± 4.3	26.0 ± 4.2
$\dot{V}O_2$ max(ml/kg·min)	Pre-T	35.9 ± 4.3	36.4 ± 5.5	40.3 ± 5.9	42.6 ± 6.7
	Post-T	36.3 ± 4.3	38.0 ± 5.4	39.8 ± 4.5	42.7 ± 6.3
HRmax (BPM)	Pre-T	179 ± 10	183 ± 11	183 ± 9	179 ± 7
	Post-T	178 ± 12	181 ± 9	180 ± 11	178 ± 9
$\dot{V}_E$ max (l/min BTPS)	Pre-T	125 ± 25	117 ± 22	128 ± 24	131 ± 26
	Post-T	127 ± 27	121 ± 24	130 ± 24	133 ± 28

*Pre-T = pre-training; Post-T = post training

30%) found herein would appear to be rather high. However, similarly high levels of body fat have been reported by others (1,10) for the 40 and over age group.

Plasma cholesterol has been shown to be an important risk factor with evidence suggesting a gradient of risk with increasing levels (8). In the present study, 61.8% of the total sample had serum cholesterol levels greater than 200 mg/dl with 17.8% being greater than 250 mg/dl. In a military population aged 35 and over, Denniston et al. (4) reported incidences of 45% for cholesterol levels greater than 200 mg/dl and 6% for those greater than 250 mg/dl.

Extensive data from several prospective studies have demonstrated a significant relationship between cigarette smoking and coronary artery disease (8). The high prevalence of smokers (50%) found in the present study is similar to that reported for other military populations (4) and represents the most predominant risk factor in this group. While some evidence suggests that cigarette smoking decreases with age (11), the prevalence of smokers did not change with age in the present study. While no conclusions can be drawn from such data, they do emphasize the cardiovascular risk of this factor in the military environment.

A direct inverse relationship between levels of cardiorespiratory fitness and variables related to an increased risk for coronary disease was seen. Since the data are cross-sectional in nature, a cause and effect relationship between physical activity and risk factor values cannot be inferred. However, a substantial difference between high and low levels of aerobic fitness is apparent. While the differences among the intermediate levels of fitness groups are less pronounced, these data strongly support the hypothesis that protection from coronary artery disease appears to be associated with a higher level of fitness (14). Assuming coronary risk factors are related directly to the frequency of coronary disease and that physical activity can affect these factors, then physical activity and thus the level of aerobic fitness may be important in reducing mortality from coronary artery disease. However, only longitudinal studies will show if decreasing the magnitude of these factors has any effect in reducing or delaying the onset of the disease.

A large body of data has accumulated over the past few years concerning the effects of physical training on cardiorespiratory fitness (16). These studies have shown that any improvement in $\dot{V}O_2$ max is directly related to the frequency, intensity, and duration of training. Depending on the quantity and quality of training, such improvement in $\dot{V}O_2$ max has been shown to range from 5% to 25%. Age in itself does not appear to be a deterrent to endurance fitness. Recent studies in subjects 20 to 63 yrs of age have shown that the relative change in $\dot{V}O_2$ max with training in middle-aged and older men is similar to that seen in younger age groups (17,19).

Based upon the available data, therefore, an increase of 10-15% in $\dot{V}O_2$ max could be expected for subjects who take part in aerobic training on a regular basis for 6 months (16). In the program evaluated in the present study, a large number of subjects (44%) who were initially designated as inactive did not participate in the program while those who were originally inactive but did participate showed only a 4.4% increase in $\dot{V}O_2$ max. This insignificant change suggests that these subjects did not train at an appropriate intensity, duration and frequency to stimulate the cardiorespiratory system.

While it is difficult to establish an accurate "drop-out" rate since many subjects were unavailable for interview at the completion of the study, the percentage of nonparticipants in the inactive group is similar to data from other studies on non-compliance. Oldridge (13), in reviewing a series of studies on the compliance of apparently healthy male subjects, found an overall compliance of approximately 55% in training programs of 6 months or more in duration. While the Army recognizes the need for improved aerobic fitness in its 40 and over aged members, the results of this study suggest that the approach evaluated here to accomplish this end was not satisfactory. According to Wilmore (21), any successful exercise program must accomplish two major goals: (1) teach the participants why they should become physically active, and (2) motivate them to follow through with a training program.

Approximately 46% of the subjects who were initially tested indicated that they participated in their own personal training program. These subjects, who comprised the moderately active and active groups, had a $\dot{V}O_2$ max which can be considered good to excellent for their age (20). It is obvious, however, that much research is needed in the areas of education and motivation to find ways for those less physically fit to comply with self-administered training programs. In the military for the 40 and over aged soldier there is an absence of any occupationally-related requirement for physical fitness as well as a lack of a structured physical training program. These necessitate that participation in physical activity be left to individual initiative. The results of this study show, however, that merely providing subjects with a written program for the development of aerobic fitness, is unsatisfactory. This suggests that to improve participation in physical training in the Army will require an increased emphasis on supervision of the program and methods of positive reinforcement so individuals will maintain motivation and interest.

V. CONCLUSIONS

1. The level of aerobic power as measured by $\dot{V}O_2$ max in 40 and over aged Army personnel was not significantly different from that reported for civilian populations of comparable age.

2. The most prevalent coronary risk factors in the sample studied were obesity (63.8% with body fat content greater than 25%), serum cholesterol (61.8%

with levels greater than 200 mg/dl; 17.8% greater than 250 mg/dl), and smoking history (50.3% smokers).

3. An inverse relationship was found between levels of cardiorespiratory fitness and such coronary risk factors as blood pressure, serum cholesterol, obesity, fasting blood sugar and smoking history.

4. An unsupervised, self-administered, aerobic training program as described herein was ineffective in eliciting a significant improvement in aerobic power.

REFERENCES

1. Cooper, K.H., M.L. Pollock, R.P. Martin, S.R. White, A.C. Linnerud and A. Jackson. Physical fitness levels vs. selected coronary risk factors. A cross-sectional study. JAMA 236:166-169, 1976.

2. Cumming, G.R. and L.M. Borysyk. Criteria for maximum oxygen uptake in men over 40 in a population survey. Med. Sci. Sports 4:18-22, 1972.

3. Daniels, W.L., D.M. Kowal, J.A. Vogel, and R.M. Stauffer. Physiological effects of a military training program on male and female cadets. Aviat. Space Environ. Med. 50:562-566, 1979.

4. Denniston, J.C., R.E. Jackson, W.P. Morgan, M.U. Ramos, J.L. Szurek and J.A. Vogel. A survey of cardiopulmonary health and coronary risk factors in a select military population. Milit. Med. 141:440-444, 1977.

5. Durnin, J.V.G.A., and J. W. Wormsley. Body fat assessed from total body density and its estimation from skinfold thickness; measurements on 481 men and women aged from 16 to 72 years. Brit. J. Nutr. 32:77-92, 1974.

6. Froelicher, V.F., M. Allen and M.C. Lancaster. Maximal treadmill testing of normal USAF aircrewman. Aerospace Med. 45:310-315, 1974.

7. Hanson, J., B. Tabakian, A. Levy, and W. Nedde. Long-term physical training and cardiovascular dynamics in middle-aged men. Circulation 38:783-799, 1968.

8. Kannel, W.B., T.R. Dawber, A. Kagon, N. Revotskie and J. Stokes. Factors of risk in the development of coronary heart disease-six-year followup experience. The Framingham Study. Ann. Intern. Med. 55:33-50, 1961.

9. Kannel, W.B., D. McGee, and T. Gordon. A general cardiovascular risk profile: The Framingham Study. Amer. J. Cardiol. 38:46-51, 1976.

10. Kowal, D.M., J.A. Vogel, J. Paris, and J. Hodgdon. Exercise tolerance, coronary risk factors, and aerobic capacity of older military personnel. The Physician and Sports Medicine. 6:85-90, 1978.

11. Myles, W.S. and C.L. Allen. A survey of aerobic fitness levels in a Canadian military population. Aviat. Space Environ. Med. 50:813-815, 1979.

12. Naughton, J. and F. Nagle. Peak oxygen uptake during physical fitness program for middle-aged men. JAMA 191:103-105, 1965.

13. Oldridge, N.B. Compliance with exercise programs. In: Heart Disease and Rehabilitation. M.L. Pollock and D.H. Schmidt, Eds. Houghton Mifflin, Boston, MA. pp.619-629, 1979.

14. Paffenbarger, R.S. and W.E. Hale. Work activity and coronary heart mortality. New Eng. J. Med. 292:545-550, 1975.

15. Patton, J.F., W.L. Daniels and J.A. Vogel. Aerobic power and body fat of men and women during Army basic training. Aviat. Space Environ. Med. 51:492-496, 1980.

16. Pollock, M.A. The quantification of endurance training Programs. In: Exercise and Sports Sciences Reviews, J.H. Wilmore (Ed.). Academic Press, New York, NY, 1973.

17. Pollock, M.L., H.S. Miller, R. Janeway, A.C. Linnerud, B. Robertson, and R. Valentino. Effects of walking on body composition and cardiovascular function of middle-aged men. J. Applied Physiol. 30:126-130, 1971.

18. Ribisl, P. Effects of training upon the maximal oxygen uptake of middle-aged men. Intern. Z. Angew. Physiol. 27:154-160, 1969.

19. Saltin, B., L. Hartley, A. Kilbom, and A. Astrand. Physical training in sedentary middle-aged and older men. II. Scand. J. Clin. Lab. Invest. 24:323-334, 1969.

20. Shepard, R.J. World standards of cardiorespiratory performances. Arch. Environ. Health. 13:664-672, 1966.

21. Wilmore, J.H. Individual exercise prescription. Amer. J. Cardiology. 33:757-759, 1974.

22. Wilmore, J., J. Royce, R. Girandola, F. Katch, and V. Katch. Physiological alterations resulting from a 10 week program of jogging. Med. Sci. Sports 2:7-14, 1970.

23. Wolthuis, R.A., V. F. Froelicher, J. Rischer, I. Noguera, G. Davis, A.J. Stewart and J.H. Triebwasser. New practical treadmill protocols for clinical use. Amer. J. Cardiology 39:697-700, 1977.

STAMP Security Classification here